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DECLARATION

The undersigned, Dana Scruggs, having an office at 8902B Otis Avenue, Suite 204B, Indianapolis, Indiana 46216, hereby states that she is well acquainted with both the English and German languages and that the attached is a true translation to the best of her knowledge and ability of PCT/DE 03/01698 (INV.: MATUSCHEK, J., ET AL.), entitled "Driveway for Magnetically Levitated Vehicles".

The undersigned further declares that the above statement is true; and further, that this statement was made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or document or any patent resulting therefrom.



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6/ppts.

DRIVEWAY FOR MAGNETICALLY LEVITATED VEHICLES

The present invention relates to a driveway for magnetically levitated vehicles according to the general class indicated in the definition of the species in Claim 1.

Driveways for magnetically levitated vehicles are known in various configurations. They typically include a large number of supports anchored in a primary supporting framework and installed along a predetermined track at a height of one meter or more, and they include driveway carriers that are, e.g., approximately 12 m to approximately 62 m in length arranged on said supports. All pieces of equipment needed to operate a magnetically levitated vehicle are fixed to the carriers, e.g., stator cores, lateral guide rails, slide rails, and the like. When steel carriers are used, in order to enable the necessary temperature-induced expansions to occur, said carriers are supported in a fixed manner at a center part and at its ends on associated supports in a movable manner that depends on the type of movable bearing. The movable bearings are realized as elastomer-Teflon sliding bearings, for example, which are installed in a manner that allows them to be replaced easily using screws (e.g., ZEV-Glas, Ann. 105, 1981, No. 7/8, pp 205 – 215 and DE 34 04 061 C1).

In addition, vehicles of the general class described initially are known; the driveway components of said vehicles are composed of steel and have relatively short lengths of, e.g., approximately 6 m or less, down to 2 m, and are intended for "ground-level" operation of magnetically levitated vehicles in particular. Driveway modules of this type formed the basis of the request for bids for the ground-level components of the Berlin-Hamburg magnetically levitated driveway, for example; they are anchored at their ends in a foundation built on the ground, the ends being anchored with the aid of fastening devices containing the supporting bearings made of steel, and said ends being fastened to the underside of the modules. The known supporting bearings are composed of

1 approximately 1 m-high crossties or dividers which fulfill the necessary support
2 function in the vertical direction and the function of a movable bearing in the
3 longitudinal direction of the driveway. For this purpose, the supporting bearings
4 are made of the same material as the carrier, i.e., construction steel, and are
5 integrally joined with the modules by welding.

6
7 Due to the constructional method described, the application of supporting
8 bearings of this type is limited. If the supporting bearings are located at an
9 adequate height of a meter or more, they can absorb the stresses in the
10 longitudinal direction which occur due to temperature-induced expansions of the
11 driveway, and the vertical loads which occur during operation of the magnetically
12 levitated vehicles. In the interest of locating the driveway as close to ground level
13 as possible, the shorter the configuration of the supporting bearings is, however,
14 the less favorable are the stress ratios of the deformations which inevitably occur
15 as a result of temperature fluctuations. With the desired low construction heights
16 of less than one meter and the known constructional method, this results, in the
17 end, in plastic deformations of the supporting bearings and in fractures in the
18 region of the welding points in particular. Reducing the cross sections of the
19 supporting bearings in order to increase their bending property would not change
20 this by much; instead, it could possibly result in a level of stress on the
21 supporting bearings that would be impermissible for operation of the magnetically
22 levitated vehicles. Adding to this is the fact that, if a supporting bearing becomes
23 defective, the entire associated carrier would have to be replaced, since repairs
24 cannot be performed on-site.

25
26 Finally, driveways for magnetically levitated vehicles are known (DE 198 08 622
27 C2), with which the individual modules are not fastened directly to a primary
28 supporting framework in the form of a foundation built on the ground, but instead
29 are fixed to a primary supporting framework which is mounted on supports which
30 are supported on the ground. The modules, made of concrete in this case, are
31 provided with openings on their undersides which accommodate fastening

1 devices having the function of a fixed or movable bearing. The detailed
2 configuration of said fastening devices that allows them to function as a fixed or
3 movable bearing cannot be determined from this known proposed design.

4
5 Based on this, the problem of the present invention is to design the driveway of
6 the general class initially described such that it is suited for installing the
7 driveway modules on the primary supporting framework without increasing the
8 tendency to break, and to enable defective supporting bearings to be replaced.

9
10 The characterizing features of Claim 1 serve to attain this object.

11
12 The present invention has the advantage that, due to the properties of spring
13 steel, the supporting bearing made of spring steel can compensate for the
14 inevitable deformations of the modules that occur even with low construction
15 heights and can absorb the stresses that occur as a result without the risk of
16 breaking. It has also been proven that the forces which occur perpendicularly to
17 the driveway during operation of the magnetically levitated vehicles can be fully
18 absorbed by the supporting bearings made of spring steel without incurring an
19 impermissible risk of buckling or compromising the driving properties. The
20 detachable connection of the supporting bearing with the module also ensures
21 that the two can be easily separated from each other, which greatly simplifies the
22 replacement of a defective supporting bearing as compared with the integral
23 and/or welded versions.

24
25 Further advantageous features of the present invention result from the
26 subclaims.

27
28 The present invention is explained in greater detail below with reference to
29 exemplary embodiments in combination with the attached drawing.

30

Figure 1 shows a schematic side view of a typical driveway for magnetically levitated vehicles composed of a plurality of modules;

Figure 2 shows a larger-scale, perspective view of a module according to Figure 1, and its fastening devices;

Figures 3 and 4 show a transverse and longitudinal sectional view through the module according to Figure 2 in the region of the fastening device;

Figure 5 shows a schematic longitudinal sectional view through a second exemplary embodiment of the fastening device according to the present invention;

Figure 6 shows a sectional view along the line VI-VI in Figure 5;

Figure 7 shows a schematic longitudinal sectional view through a third exemplary embodiment of the fastening device according to the present invention; and

Figure 8 is a bearing scheme for a module according to Figures 1 through 7.

Figure 1 is a schematic illustration of two variants of a driveway for magnetically levitated vehicles. The driveway contains a plurality of driveway modules 1, which are arranged in tandem in the longitudinal direction (arrow \underline{x}); said driveway also has the pieces of equipment needed to operate the magnetically levitated vehicles but which are not shown individually, such as stator cores, lateral guide rails, slide surfaces, etc. The length of each module 1 measured in the x direction is 6.192 m, for example, while its width is 2.80 m, for instance, depending on the particular type of vehicle.

Each module 1 is supported on a primary supporting framework, which can be individual concrete foundations (Figure 1, bottom) built on the ground, a concrete

1 foundation extending continually in the x direction (Figure 1, top), or a driveway
2 carrier, for example, which itself is supported by supports on the ground or a
3 foundation built on the ground. For the purposes of the present invention, it does
4 not matter in principle how the primary supporting framework is configured in a
5 specific case. Even when the primary supporting framework is different, the same
6 constructional method with components that are the same or are adapted to the
7 course of the track is always used for the driveway module.

8
9 Magnetic driveways are known from publications ZEV-Glas, Ann. 105 (1981), No.
10 7/8, pp 205 through 215; DE 298 09 580 U1 and EP 1 048 784 A1, for example.
11 Said publications are therefore made part of the subject of the present disclosure
12 via reference.

13
14 The support of modules 1 on primary carrier 2 takes place according to the
15 present invention with the aid of fastening devices 3 and 4. A fastening device 3
16 located essentially in the center of the module thereby fulfills the function of a
17 fixed bearing, while fastening devices 4 provided at the two ends of the module
18 have the function of movable bearings. As a result, modules 1 are held stationary
19 in the center part, while their sections extending away from the center and toward
20 the two sides undergo the usual temperature-induced expansions and
21 contractions.

22
23 According to the present invention, fastening devices 4 have supporting bearings
24 in the form of band-shaped or rod-shaped elements which are composed of
25 spring steel and are yielding in the selected x direction (Figure 1), but, in the y
26 direction perpendicular thereto, i.e., perpendicular to the plane of the drawing in
27 Figure 1, they are substantially rigid. As a result, fastening devices 4 serve not
28 only to fasten modules 1 to primary supporting framework 2, they also support
29 the parts of module 1 coupled thereto in such a manner that they are
30 displaceable relative to the primary supporting framework.

31

1 According to an exemplary embodiment of the present invention considered to be
2 the best so far (Figures 2 through 4), each supporting bearing contains two band-
3 shaped bearing elements 5 and 6 arranged in parallel with each other, the
4 bearing elements being designed as leaf springs capable of bending in the x
5 direction, depending on the type. Bearing elements 5 and 6 bear via top ends of
6 diametrically opposed sides against plane surfaces, which are configured in yz
7 planes (Figures 3 and 4)—arranged perpendicularly to the x direction—on
8 mounting rails 7. Mounting rails 7 are integrally mounted, as crossties, on the
9 ends of module 1 and project therefrom essentially vertically downward in the z
10 direction, so that the wide sides of bearing elements 5, 6 are also arranged
11 substantially perpendicularly to the x direction. The lower ends of bearing
12 elements 5, 6 bear against plane surfaces via both sides in a corresponding
13 manner, the plane surfaces being applied to a mounting rail 8a, which is provided
14 at the upper end of a fastening anchor 8. Fastening elements in the form of
15 mounting screws 9 and 10 and bolts 11 and 12 screwed thereon serve to fasten
16 bearing elements 5 and 6 to mounting rails 7 and 8a. The arrangement according
17 to Figures 3 and 4 is configured such that the two bearing elements 5, 6, in the
18 fastened state, are arranged in parallel and in an essentially congruent manner.
19 In addition, the two bearing elements 5, 6 are advantageously made of the same
20 spring steel and are provided with the same dimensions.

21
22 As shown in Figure 2, in the exemplary embodiment, at the two longitudinal ends
23 of module 1, two fastening devices 4 are each provided with one pair of bearing
24 elements 5, 6, all of which are yielding in the x direction. In contrast, at least one
25 further fastening device 3 located in a center region of module 1 (refer to Figure
26 1) includes at least one largely rigid bearing element 14, which is fastened to the
27 underside of module 1 with screws and bolts in a manner similar to bearing
28 elements 5, 6, and functions as a fixed bearing. In a manner similar to bearing
29 elements 5, 6, bearing element 14 can be fixed to the underside in a detachable
30 manner with the aid of mounting screws, which are not shown.

31

1 Plate-shaped spacers and/or spacer sheets 15 are preferably located between
2 mounting rails 7 and bearing elements 5, 6. They serve to permit springy
3 motions of bearing elements 5, 6 without their contacting mounting rails 7 or
4 deforming around their lower ends. On the other hand, relatively short spacers 15
5 can increase the size of the lever arms of bearing elements 5, 6, which improves
6 the spring properties.

7

8 Module 1 can be mounted on primary supporting framework 2 made of concrete
9 as shown in Figures 3 and 4 by providing recesses 16 on the top side of said
10 primary supporting framework and at the points where fastening anchors 8 come
11 to rest, the recesses accommodating part of the lower ends of fastening anchors
12 8 and being filled with (secondary) mortar 17 at the latest after module 1 has
13 been installed on primary supporting framework 2. The entire module 1 is then
14 arranged, using bearing elements 5, 6 and 14, at a preselected distance of, e.g.,
15 0.2 m to 1 m above the surface of primary supporting framework 2.

16

17 An alternative exemplary embodiment of the invention is shown in Figures 5 and
18 6. In this case, a fastening device 4a has supporting bearings that are provided
19 not with band-shaped bearing elements, but rather a plurality of rod-shaped
20 bearing elements 18 in the form of rods having a square cross section. Bearing
21 elements 18 are mounted on the undersides of modules 1 in a cruciform pattern,
22 for example, as shown in Figure 6, and are secured to primary supporting
23 framework 2 in a not-shown manner (e.g., analogous to Figures 3 and 4).

24 Bearing elements 18 are composed of flexural members, for example, which are
25 flexible at least in the x or y direction and practically in all directions transversely
26 to their longitudinal axes when round cross sections are used. They then
27 essentially perform the function of floating bearings, which can absorb forces in a
28 plurality of directions, such as those that occur during temperature fluctuations.

29 The number of bearing elements 18 used per fastening device 4a depends in
30 particular on the materials selected and the desired distance of modules 1 from
31 primary supporting framework 2.

Figure 7 shows a further exemplary embodiment according to the invention for fastening modules 1 to primary supporting framework 2. In this variant, a fastening device 4b has a supporting bearing in the form of a band-shaped bearing element 19 which corresponds to bearing elements 5 and 6 in Figures 2 through 4, which said bearing element 19 is connected in a fixed manner at its lower end with a connecting flange 20. Bearing element 19 is provided with a corresponding connecting flange 21 at its upper end. In addition, corresponding connecting flanges 22 and 23 located at the particular fastening sites are fixed, e.g., by welding or secondary mortar, to the underside of module 1 and to the top side of primary supporting framework 2. Then, it is only necessary to first fasten bearing elements 19 to primary supporting framework 2 using flanges 20 and with the aid of mounting screws 24 extending through said flanges, then to place modules 1 with their flanges 22 on flanges 21 and, finally, to connect the two flanges 21, 22 using mounting screws 25 extending through them. The advantage of this is that modules 1 and bearing elements 19 are connected with primary supporting framework 2 in an easily detachable manner and can be easily removed and replaced, if necessary. This variant also offers the advantage that, by inserting shims between flanges 21, 22, it is easy to align the individual modules with the track and in the region of the joints without misalignment on primary supporting framework 2.

In the exemplary embodiment according to Figures 5 and 6 as well, flanges 26, 27 corresponding to flanges 21, 22 can be provided to detachably connect bearing elements 18 with modules 1 using mounting screws 28. It is also clear that bearing elements 18 and 19 can also be equipped at their ends with other fastening elements which are configured in accordance with Figures 2 and 4, for example, the fastening elements being easily fastened to modules 1 and primary supporting frameworks 2 and easily detached therefrom, if necessary.

In an underside view of module 1, Figure 8 shows a schematic depiction of one of the many possible arrangements of fastening devices 3, 4, 4a and 4b for

fastening modules 1 to primary supporting framework 2. The action of various fastening devices 3, 4, 4a and 4b is indicated using different markings. In particular, line 29 indicates the function of a movable bearing effective in the x direction, line 30 indicates the function of a movable bearing effective in the y direction, cross 31 indicates the function of a fixed bearing, and circle 32 indicates the function of a floating bearing described with reference to Figures 5 and 6. The various types of fastening devices can be installed at selected points on module 1 as necessary. In addition, bearings 30 and 32 can also usually be eliminated entirely.

A substantial advantage of the exemplary embodiments according to Figures 2 and 7 is that modules 1 and bearing elements 14 can be made of a material which is sufficiently rigid for static purposes, while spring elements 5, 6, 18 and 19 can be made of a spring steel that allow temperature-induced expansions and contractions to occur. A further advantage resulting therefrom is that fastening devices which are very short in the z direction and, therefore, low installation heights for modules 1 above primary supporting frameworks 2 can be realized. Finally, a substantial advantage is that redundancy results due to the use of bearing elements 5, 6 in Figures 2 through 4 in pairs. Even if a bearing element 5, 6 of one pair breaks, adequate bearing capacity remains for emergency operation. The same applies for the exemplary embodiment according to Figures 5 and 6.

Movable bearings effective in the y direction are not provided in the exemplary embodiment according to Figures 2 through 4. They can be eliminated if the expected temperature-induced expansions and/or contractions are relatively minor, e.g., due to small module widths of 1 m, for example. It is also clear that, instead of using bearing elements or leaf springs 5, 6 in pairs, it is also possible to use just one bearing element or more than two bearing elements per bearing site.

1 An advantage of the present invention compared to integral bearings is that the
2 supporting bearings can be replaced if any type of defect occurs, without
3 damaging associated module 1 and therefore needing to replace it. Exemplary
4 embodiments according to Figures 2 through 4, 5 and 6 and 7 enable particularly
5 easy replacement in particular when mounting screws 10 and 24, bolts 12 and
6 flanges 23 are easily accessible from the outside, i.e., they do not disappear in
7 secondary concrete or the like. In this case, one only needs to loosen screws 10
8 and/or 24, and 9 and/or 25, 28, remove the defective supporting bearings, and
9 install new ones. With the exemplary embodiments according to Figures 5
10 through 7 it would also be possible, after loosening mounting screws 25, 28, to
11 first remove associated module 1, remove the defective supporting bearings
12 and/or bearing elements 18, 19, e.g., by breaking secondary mortar 16 used in a
13 manner similar that shown in Figures 3 and 4, install new fastening devices 4a,
14 4b, and, finally, to connect previously-removed module 1 with the new fastening
15 devices.

16
17 The present invention is not limited to the exemplary embodiments shown, which
18 said exemplary embodiments can be modified in numerous ways. This applies,
19 for example, for the design of modules 1 and primary supporting frameworks 2.
20 In particular, it does not matter whether modules 1 are fastened to a primary
21 supporting framework 2—using fastening devices 4, 4a and 4b—in the form of a
22 foundation built on the ground, or in the form of a supporting structure which itself
23 is supported by supports or the like on the ground or on a foundation built on the
24 ground. Fastening devices 4, 4a and 4b could be used in a similar manner to
25 fasten modules 1 in the form of supporting elements on which further modules—
26 with the pieces of equipment installed—are fastened with the aid of
27 corresponding or different fastening devices. The expressions “module” and
28 “primary supporting framework” are therefore intended to be understood in the
29 most general sense within the framework of the present invention. The form and
30 number of supporting bearings provided in the specific case does not matter, in
31 principle. Furthermore, instead of mounting screws 9, 10, 24, 25 and 28

1 described, it is also possible to use other fastening elements in the form of bolts
2 secured with pins, rivets, or the like. Finally, it is also understood that the various
3 features can also be used in combinations other than those presented and
4 described here.

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